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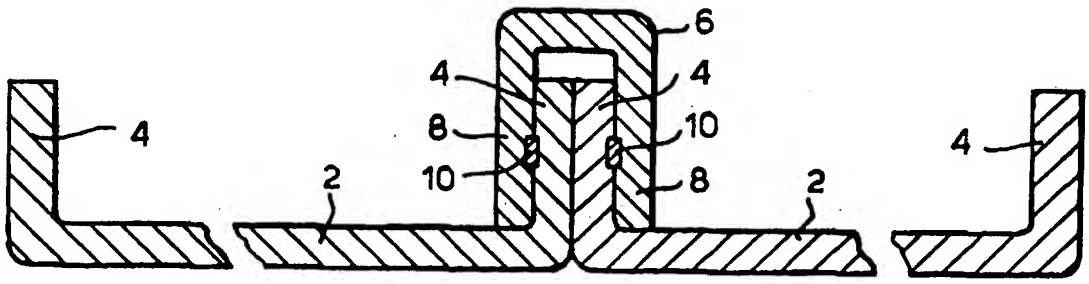

(57) Abstract

The invention provides a structure made from a plurality of thermoplastic fusionable panel units (2) and connecting pieces (6), in which the panel units (2) are formed by extrusion and the panel units and/or connecting pieces are provided with at least one electrical conductor (10) extending along a surface area in the direction of extrusion, and the connection between contacting panel units and/or the panel units and the connecting pieces, is effected by mechanical joining means (12), as well as by fusion, thereby forming a non-sliding, rigid and thermally insulated structure. A method of forming such structures is also provided.

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STRUCTURES MADE OF PANEL UNITS AND CONNECTING PIECES AND A METHOD OF FORMING SUCH STRUCTURES

Field of the Invention

The present invention relates to structures made of panel units and connecting pieces, as well as to a method of forming structures essentially made of panel units and of panel units and connecting pieces. More particularly, the present invention relates to structures and a method of forming structures made of extrudable and fusionable material, such as plastic.

Background of the Invention

There are known panel units and connecting pieces produced by extrusion for the purpose of forming wall or roof sections, as well as other like structures, e.g., the structures described in European Patent Specification No. 0 050 462. Usually, such units and pieces are made of plastic and advantageously some are light-transmitting. These structures possess improved features, such as flexibility and low weight and are relatively inexpensive. One of the major disadvantages, however, of these kinds of structures is the need to support same by rigid supporting members made of metal or wood, or of any other rigid material, so as to render the assembled structures with sufficient rigidity to withstand pressures and forces applied thereto, such as winds and the weight of snow.

Since plastic material is relatively flexible, the rigidifying and supporting members must be introduced at relatively small distances from each other, resulting in additional cost and in an inferior architectural appearance. In addition, supporting structures, usually made of metal, are detrimental to thermal insulation and are corrosive.

The common manner of improving the rigidity of such panel units is to produce same with larger inertial moment, namely, with a large bending moment. Another manner, *per se* known, to achieve rigidity of panels and of panel-based

structures, is to form panels consisting of an upper sheet and a lower sheet, interconnected by a plurality of partitions of large dimensions. The spacing between the sheets, namely, the distance of the material from the center of gravity will, *inter alia*, determine the rigidity of the structure. Since, however, such structures are efficiently produced by extrusion, the more sheets and partitions in a single panel, the greater number of extrusion dies required. Also, in order to achieve a large moment of inertia and hence rigidity, there must be invested greater effort in providing a costly die and the inevitable complications in operating such a device.

The disadvantages of utilizing structures of large dimensions reside in the relatively high transport costs of such structures, and the fact that the bending or curving thereof to assume a desired configuation requires heating, which is cumbersome and expensive. The latter is compounded by the even higher transport cost, in view of the added volume which bent or curved structures occupy. Finally, the production of large structures is accompanied by higher production and maintenance expenses, as a production flaw or damage caused thereafter to a unit, requiring its replacement, is more expensive. Hence, the solution of increasing the structure's size for rendering same more rigid is neither practical nor commercial.

The interconnection between modular panel units and connecting pieces to form structures by means of adhesives is also problematic, since, for good results, adhesives should be applied only on clean surfaces, which clean surfaces are difficult to maintain on production and construction sites. In addition, adhesives tend not to be sufficiently reliable to provide strong bonds for structural assemblies; they normally contaminate the panels during application; they are not completely weather withstandable, and in time, they tend to become non-transparent. In addition, adhesives are made of different materials than the

material of the panel units and connecting pieces and hence, the thermal expansion which takes place may add to the unreliability of such bonding, which becomes weakened in time.

Summary of the Invention

It is therefore a broad object of the present invention to overcome the above and other disadvantages of the present techniques of forming structures from modular panel units and connecting pieces.

It is a further object of the present invention to provide a structure and a method of forming such a structure made of panel units and of panel units and connecting pieces formed of extrudable and fusionable material.

It is still a further object of the present invention to provide a structure and a method of forming structures essentially assembled of panel units or of panel units and connecting pieces, providing substantially rigid and thermally insulated structures.

According to the present invention, there is therefore provided a structure made from a plurality of thermoplastic fusionable panel units and connecting pieces, characterized in that at least said panel units are formed by extrusion and said panel units and/or connecting pieces are provided with at least one electrical conductor extending along a surface area in the direction of extrusion, and that the connection between contacting panel units and/or the panel units and the connecting pieces, is effected by mechanical joining means, as well as by fusion, thereby forming a non-sliding, rigid and thermally insulated structure.

The invention further provides a method of forming rigid structures essentially assembled of thermoplastic fusionable panel units and connecting pieces, comprising producing structural panel units of extrudable and fusionable material and providing connecting pieces, applying at least one electrical conductor along a longitudinally extending surface area, or at close proximity to a

surface area of said panel units and/or connecting pieces, contacting said surface area with a surface area of another panel unit and connecting the units by said connecting pieces to form a self-sustained structure, applying pressure along at least sections of said contacting surface area, and passing current through said electrical conductor to cause the contacting surface areas along said electrical conductor to fuse, thereby forming a non-sliding, rigid and thermally insulated structure.

With the method of the present invention, it is possible to form the structure at the building site. It also provides an efficient manner of forming bent structures tailored to fit configurations of specific sites.

The invention will now be described in connection with certain preferred embodiments with reference to the following illustrative figures so that it may be more fully understood.

With specific reference now to the figures in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

Brief Description of the Drawings

Fig. 1 is a cross-sectional view of two flanged panel units and a connecting piece according to the present invention;

Fig. 2 is a cross-sectional view of another embodiment of two flanged panel units and a connector piece;

Fig. 3 is a perspective view of the connecting piece of Fig. 2, showing the electrical conductors;

Fig. 4 is a cross-sectional view of a double-glazed structure, according to the invention, and

Fig. 5 is a perspective view of a portion of a bent double- glazed structure formed in accordance with the present invention.

Detailed Description of the Preferred Embodiments

In Fig. 1, there are shown two solid panel units 2 of the type having joining flanges 4. The panels are made of extrudable and fusionable material such as plastic material. There is also provided a connector piece 6 adapted to be pushed over the joining flanges 4, so as to join the outside surfaces of the flanges by pressure to establish a self-sustaining structure. For forming a rigid, thermally insulating wall or roof structure, each of the panels 2 and/or wing portions 8 of the connecting piece 6 is provided with a conductor 10 in the mid-section of one of the flanges 4, or at the edges of the wing portions 8 of the connector piece 6, or at any other location where the surfaces of the connecting piece 6 are in contact with the flanges 4. Upon the passing of a suitable current through the conductors 10, the flanges 4 are fused together with the connecting piece 6. Alternatively, the conductors 10 may be affixed to the bases of the flanges 4, instead of to the edges of the wing portions 12 of the connector piece 6, or may be attached onto any other suitable surface of the panel unit 2 or connecting piece 6. The electrical conductors 10 may be embedded just underneath a surface, in close proximity to the surface of a panel or of a connecting piece during production (e.g., extrusion), or may be attached thereto after the production of the panel units and connecting pieces by means of an adhesive, fusion or the like.

When fusion is used to attach the conductors to the panel units or connecting pieces, the heat required to melt the thermoplastic material from which the panel units or connecting pieces are made, can be obtained by passing current through the same conductor which is to be attached, during the attachment process. The shape of the electrical conductors can be round, as that of the commonly used resistance wire, rectanglar, a flat strip made as a strip of a metal foil, or of any other shape. The size of such a wire-shaped conductor or the width of such a strip will be determined by various considerations, including the specific material of which the panel unit and connecting piece are made, the current to be passed through the conductor, the duration of time that the current is to be passed, all for the purpose of fusing the unit to a connecting piece or to another panel unit by means of heat, as the case may be. In other words, the strength of the bond to be formed between a panel unit and another panel unit or connecting piece, will determine the size and shape of the electrical conductor in consideration of the heating capability of the conductor in fusing two contacting surfaces immediately adjacent to the conductor. The spacing between conductors will, of course, also depend on the configuration of panel units and connecting pieces used in assembling a specific structure.

The connection by fusion between, e.g., one or more panel units and at least one connecting piece for forming a structure, is effected in addition to the conventional manner of connection by mechanical means. In Fig. 2, there are shown the end portions of two *per se* known, adjacently disposed flanged panel units 2 fitted with a U-shaped connecting piece 6. Both the external surfaces of the flanges 4 and the internal surfaces of the wing portions 8 are provided with tooth-like detent means 12 for joining the units. When, however, the detent means 12 of the flanges 4 or connector piece 6 are provided with electrical conductors 10 as shown, after effecting the mechanical engagement and the

pressing together of the units and the connecting piece, the flanges 4 and the connecting piece 6 are fused, so as to furnish the structure with much higher rigidity and improved thermal insulation. The fusion of the connecting pieces with the panels effectively rigidifies the entire connecting assembly, turning the latter into a rigid rib extending along the entire connecting edges of two adjacent panels. This results in a substantial reduction in the use of supporting structures and an improvement in the aesthetical appearance of the thus-formed structure.

It should also be realized that the joining of panel units and connecting pieces in accordance with the invention, provides an additional advantage of assuring that the panel units will not slide relative to each other after assembly, as is sometimes the case when the panel units are connected to each other by conventional means.

In addition to the fusion of two adjacent panels 2 to the connecting piece 6 for the purpose of achieving a rigid assembly or structure, the panels 2 may also be directly fused to each other for added rigidity. For this purpose, there may be provided further electrical conductors 14 along connecting surfaces of adjacent panels 2, as shown in Fig. 2. For example, conductors 14 and 16 may be provided for directly interconnecting the flanges 4 or lateral edges of the panels, respectively.

The panel units 2, whether made of two interconnected sheets, as shown in Fig. 2, or made of a plurality of spaced-apart sheets interconnected by ribs, or made as a solid panel, as shown in Fig. 1, may be light-transmitting panels or even panels of optical quality. In order to achieve a reliable bonding between panel units and/or between panel units and connecting pieces, it may be of advantage to utilize units and connecting pieces of substantially the same material. This will ensure that thermal expansion between the fused parts will be substantially equal.

In Fig. 3, there is shown a connector piece 6, fitted with electrical conductors 10. According to this embodiment, the electrical conductors 10 are attached to the selected surfaces of the connector by means of adhesive aluminum foil pieces 18. In addition to their function of attaching the conductors to the surfaces, the foil pieces 18 also function as heat diffusers to avoid overheating of the fusible material (e.g., plastic) at the end portions of the connectors or panel units.

Similar to the embodiment of Fig. 2, there is shown in Fig. 4 a double-glazed wall or roof construction, formed with the use of H-shaped connectors 20 fitted with electrical conductors 10 along the detent means 12 and/or along the outside surfaces of the flanges 4 and of the end surfaces of the abutting panel units 2.

Referring to Fig. 5, there is shown the interconnecting portion of four contacting bent or bowed panel units, forming a bent or curved structure, e.g., a curved roof. The H-shaped connecting piece 20, shown in greater detail in Fig. 4, interconnects the panels 2, advantageously assembled on site, to form a bent or curved double-glazed wall or roof structure. The structure is easily bent on site due to the relative flexibility of the panel units and elongated connecting piece 20, to assume the exact bending curvature fitting a prepared support and is provisionally held in this form by the built-in detent means 12, and/or by any other externally provided panel-contacting and pressure-applying means. Thereupon, the panels are fused with the connecting piece, forming an integral, rigid, bent roof or wall structure.

The use of conventional detent means 12 may seem to be redundant when the actual improved bonding between the panel units and connecting pieces is achieved by fusion; however, such detent means, or other means, may serve as provisional connectors and contact-effecting means prior to the fusion action

permanently connecting the units and pieces by fusion. Such connectors interconnect the individual panels in such a manner as to apply contacting pressure between the edges to be fused together, thereby avoiding the need to utilize auxiliary, provisional joining and supporting elements, as well as means for clamping together joining parts, for assuring proper fusion.

It will be evident to those skilled in the art that the invention is not limited to the details of the foregoing illustrated embodiments and that the present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

CLAIMS

1. A structure made from a plurality of thermoplastic fusionable panel units and connecting pieces, characterized in that at least said panel units are formed by extrusion and said panel units and/or connecting pieces are provided with at least one electrical conductor extending along a surface area in the direction of extrusion, and that the connection between contacting panel units and/or the panel units and the connecting pieces, is effected by mechanical joining means, as well as by fusion, thereby forming a non-sliding, rigid and thermally insulated structure.

2. The structure assembly as claimed in claim 1, wherein said electrical conductor is embedded in said panel unit or connecting piece during production by extrusion.

3. The structure as claimed in claim 1, wherein said electrical conductor is applied to said panel unit or connecting piece by means of an adhesive.

4. The structure assembly as claimed in claim 1, wherein said panel unit is a light-transmitting unit.

5. The structure as claimed in claim 1, wherein said panel units consist of at least two spaced-apart sheets interconnected by partitions.

6. The structure as claimed in claim 1, wherein said panel units are solid.

7. The structure as claimed in claim 1, wherein at least at end portions of said surface area, there is provided heat-diffusing means for preventing overheating of fusible material.

8. The structure as claimed in claim 1, wherein said panel units and connecting pieces are bent after effecting the mechanical joining thereof and fused in their bent configuration to form bowed structures.

9. The structure as claimed in claim 1, wherein said connecting pieces and said flanges are provided with detent means for assembling a self-sustained

structure and for applying pressure on the contacting surfaces of said panels and connecting pieces, prior to fusing said panels and connecting pieces together.

10. A method of forming rigid structures essentially assembled of thermoplastic fusionable panel units and connecting pieces, comprising:

producing structural panel units of extrudable and fusionable material and providing connecting pieces;

applying at least one electrical conductor along a longitudinally extending surface area, or at close proximity to a surface area of said panel units and/or connecting pieces;

contacting said surface area with a surface area of another panel unit and connecting the units by said connecting pieces to form a self-sustained structure, applying pressure along at least sections of said contacting surface area, and

passing current through said electrical conductor to cause the contacting surface areas along said electrical conductor to fuse, thereby forming a non-sliding, rigid and thermally insulated structure.

11. The method as claimed in claim 10, wherein said panel unit is produced by extrusion.

12. The method as claimed in claim 10, wherein said connecting piece is produced by extrusion.

13. The method as claimed in claims 11 and 12, wherein said electrical conductor is applied to said panel unit or connecting piece during the production thereof by extrusion.

14. The method as claimed in claims 11 and 12, wherein said electrical conductor is applied to said panel unit or connecting piece after the production thereof by means of an adhesive.

15. The method as claimed in claim 10, wherein said panel unit is a light-transmitting unit.

16. The method as claimed in claim 10, comprising producing said panel units and at least one connecting piece with detent means for assembling a structure before passing current through said electrical conductor to permanently connect the panel units and connecting piece by fusion.

17. The method as claimed in claim 10, further comprising providing heat-diffusing means along at least sections of said electrical conductor prior to contacting said surface areas.

18. The method as claimed in claim 10, further comprising the step of bending said structure prior to passing current through the electrical conductors, so as to form rigid, bent structures.

Fig.1.

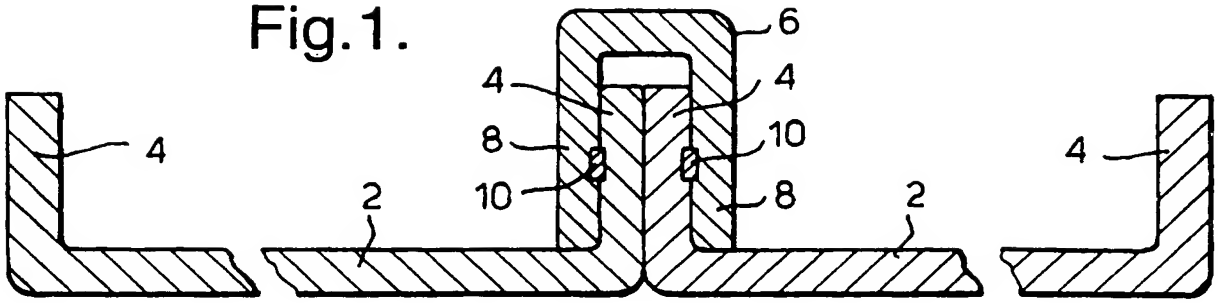

Fig.2.

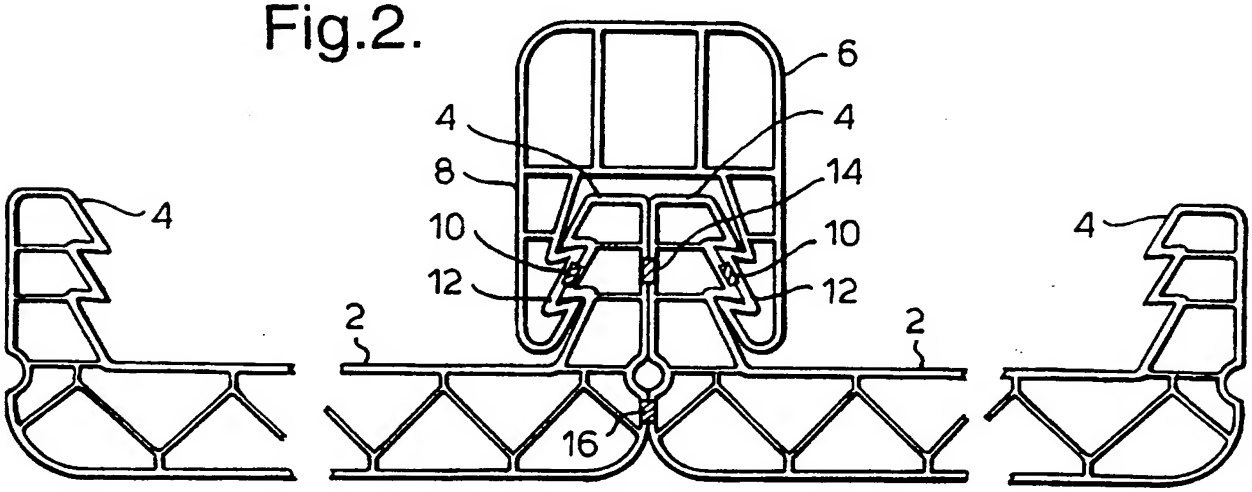

Fig.3.

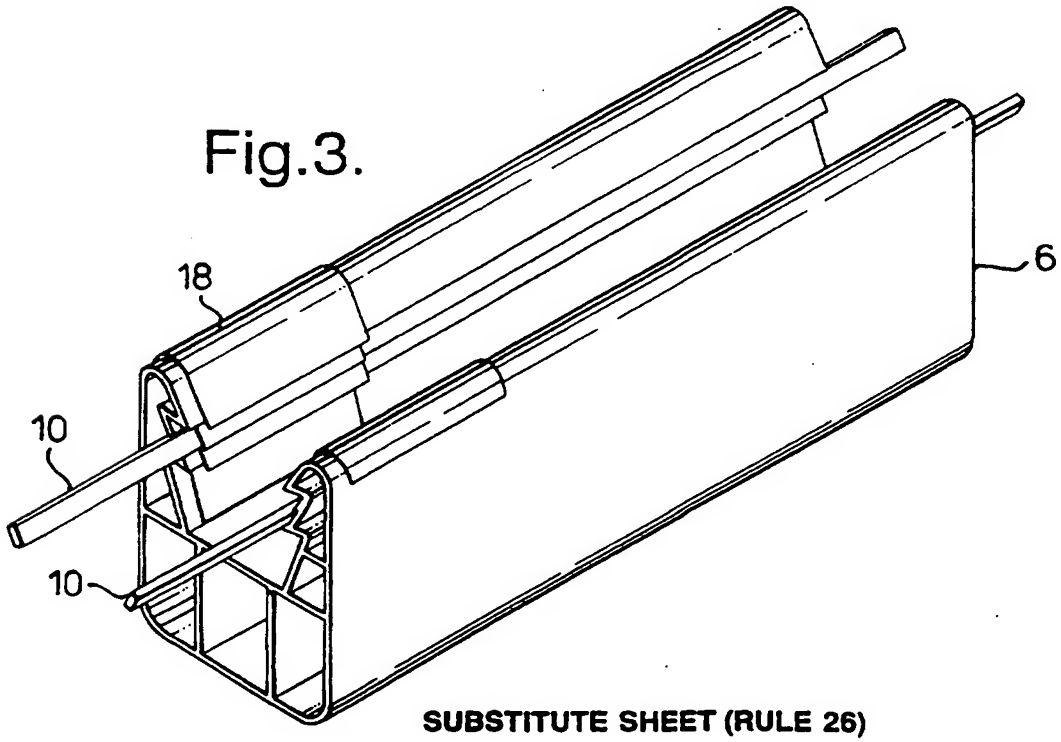

Fig.4.

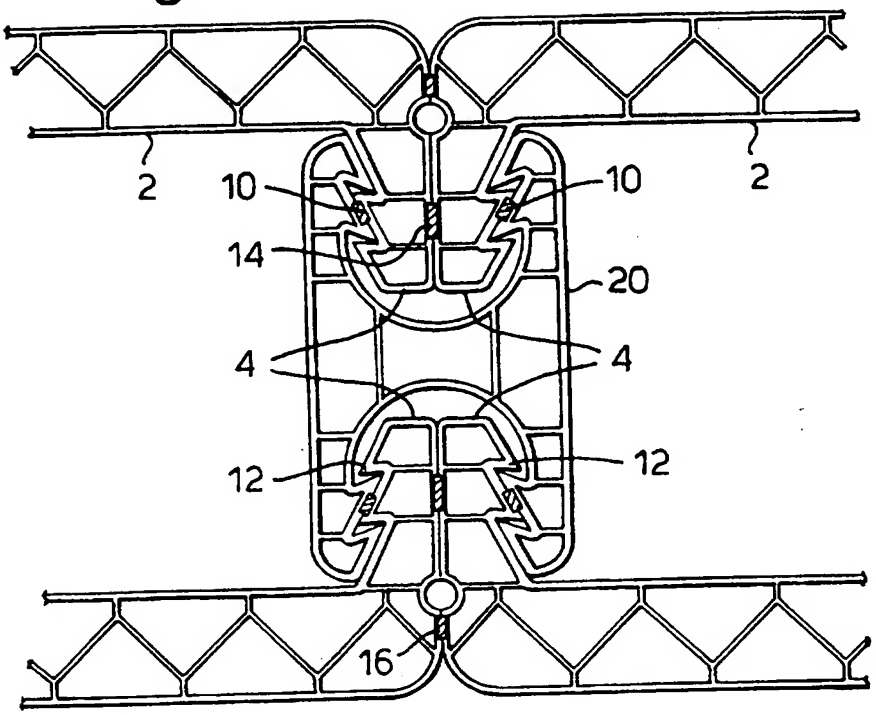

Fig.5.